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Plant Spacing Applications and Weeds Extracts against Plant Tomato (Lycopersicum esculentum, Mill) Productivity Intercropped with Aromatic Plants

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Abstract
Aims of this study are to find method to increase the productivity of tomato plants per unit area of land with the different of plant spacing and doze variation of weed extract that can enchance the productivity of tomato plants. The design used was randomized block 2 factorial design, the first factor was plants spacing which consist of 3 level, namely J1: 50 x 50 cm; J2: 50 x 60 cm; and J3: 50 x 70 cm; and the second factor was doze variation of weed extract as much as 5 level namely G0: without plant extract; G1: Cyperus rotundus extract 40g/liter; G2: Cyperus rotundus extract 80 g/liter; G3: Ageratum conyzoides extract 40 g/liter; and G4: Ageratum conyzoides extract 80 g/liter. Each of treatment combination was repeated three times.The results indicate that plant spacing is significant effect on plant height 5 WAP, number of fruits, fruit diameter, fruit weight, plant dry weight, leaf area 12 WAP and leaf area index 12 WAP. Weed extract was significant effect on number of fruits, fruit diameter, leaf area 12 WAP and leaf area index 12 WAP.
Keywords: tomato, intercropping, weed extraction, Cyperus rotundus, Ageratum conyzoides.

1. Introduction

Weed control and pest chemically in the long run can reduce the quality of the environment. Therefore, it is necessary way of weed control without the use of chemicals that have no effect on environmental degradation. Companion planting is the development of models of ecosystems by planting more than one plant species simultaneously in one area so that more diverse types of crops, pest and disease problems tend to be less than the monoculture crops, and crop diversity can reduce the risk of crop failure (Bonford, 2009).

Use of weed extract of *Cyperus rotundus* and *Ageratum conyzoides* - as weeds dominan on tomato crops- is one way to control weeds organically. Fitria study (2011) showed the potential residues of weed species *Cyperus rotundus* and *Ageratum conyzoides* not differ in influencing the growth and yield of tomato plants. Weed extract at a concentration of 40 g/liter to 120 g/liter was able to lower the total fruit weight per plant compared to the control. However, the influence of weed extracts to decrease the amount of weeds were not observed further. Messakh (2012) states that the content of secondary metabolites in the coriander, lemongrass and basil could be expected to suppress the influence of weed. Intercropping tomatoes with cilantro able to reduce pest populations around planting tomatoes.

In general, the influence of residues of a weed species on the growth of weeds and crops are intercropped with between aromatic plant species is difficult to know just by visual observation in the field. Therefore, it is necessary to investigate the influence of weed residues of *Cyperus rotundus* and *Ageratum conyzoides* in suppressing the growth of weeds in tomato plants as well as its influence on the productivity of tomato plants interplanting the sidelines aromatic plant species.

2. Literature review

Such as tomato plants, weeds also need water, nutrients and space to grow, produce fruit and seeds. According Moenandir (2010) weeds that grow adjacent to cultivated plants can cause rivalry or competition as the interaction of the two. Hersanti, et al (2005) explain that rivalry or competition occurs associated with the growing availability of facilities such as water, nutrients, sunlight, CO_2 and growing space is limited. Spacing on previous some research can restrict the growth and development of weeds that do not affect the productivity of tomato plants.

Weeds in tomato pose serious problems and affect the plant, resulting in a significant reduction in the results. Research results Laude et al. (1996) showed that the presence of weeds during the growth of tomato plants can increase tomato yield losses of up to 54.22%. This is due to weed competition with crops that take longer, so that the greater the yield loss. The decline in results due to the presence of weeds can also go through the process residues. According to Rice (1984) in Fitria (2011) *Cyperus rotundus* are residues and capable of

lowering the yield of tomatoes by 53%. Weeds not only compete with tomato plants, but also can be a host for a host of pests, diseases and nematodes that can ultimately occupy tomato plants. For example, parasitic weeds such as *Cuscuta*, spp. and *Orobanche* spp. Tomato plants can be attacked directly.

Chemical weed control must be reduced and replaced with environmentally friendly control. Weed control manually and continuously can reduce results tomatoes as a result of mechanical treatment plants that interfere with the development. Controlling weeds with herbicides can also be done with an organic herbicide of extract plant parts become weeds. Extract of *Cyperus rotundus* and *Ageratum conyzoides* allegedly can suppress weed growth predominantly on tomato plants thus increasing the productivity of tomato plants.

The interaction between the use of plant spacing and weed extract as organic herbicides in crop plants intercropped with aromatic sidelines in the form of companion planting is an alternative environmentally friendly weed control.

3. Methodology

The study was conducted in the village Manutapen, District Alak, Kupang regency, East Nusa Tenggara province, Indonesia from July to November 2014 aims to determine: 1) the effect of plant spacing and extract dominant weed in promoting growth of tomato plants intercropped with between aromatic plants; 2) the interaction between plant spacing and weed extract dominant deliver growth and yield the best tomato intercropped with aromatic plant species; and 3) and the spacing of the best weed extract was applied to interplanting between aromatic tomato plants suitable for the production of the highest organic tomatoes and environmentally friendly.

Experiments using the basic design of a randomized block design (RAK) and a factorial experiment 3 x 5. The first factor is plant spacing of which are: 50 x 50 cm (J1); 50 x 60 cm (J2) and 50 x 70 cm (J3). The second factor is the dominant weed extract (*Cyperus rotundus* and *Ageratum conyzoides*) with the following level: G0 = 0 g/liter (control); G1 = *Cyperus rotundus* 40 g/liter; G2 = *Cyperus rotundus* 80 g/liter; G3 = *Ageratum conyzoides* 40 g/ liter; G4 = *Ageratum conyzoides* 80 g/liter. Each combination treatment was repeated 3 times so that there is a (3 x 5) x 3 = 45 experimental units.

4. Results and discussion

4.1 . An Overview of Research .

The initial design of this study is a randomized block design (RAK) factorial with 2 factors, plant spacing and weed extract dose dominant on tomato plants . While the coriander plant - as a companion plant components in planting- expected to give effect as aromatic plants that affect the pest population suppression around planting tomatoes . But in the development during this study coriander growth is not good so the effect is expected to be less than the maximum . This is because growth since its inception less coriander well when planted before planting tomatoes . Therefore, repeated planting tomato plants in the land currently has aged 2 WAP. Coriander as a companion crop planting planting done at least 3 weeks before major crops planted in the land.

4.2 . Plant Height

Results of analysis of variance showed a plant spacing significantly affected plant height age 5 WAP while weed extract had no effect on plant height 5 WAP . Interactions between plant spacing and weed extract effect on plant height increment age 5 WAP .

Table 4.2 . Plant Height average 5 WAP due Dose Effect of Plant Spacing and Weed Extract

Extracts weeds dose	Plant spacing		
	J1 (50 x 50 cm)	J2 (50 x 60 cm)	J3 (50 x 70 cm)
Without extract (G0)	31.67abc	33.06abc	44.28ef
C.rotundus extract 40 g /liter (G1)	51.00g	28.39a	36.34cd
C.rotundus extract 80 g /liter (G2)	32.33abc	29.17a	35.44bc
A.conyzoides extract 40 g / liter (G3)	30.28a	28.11a	45.83f
A.conyzoides extract 80 g / liter (G4)	40.61de	32.83abc	30.61ab

Description : The figures followed by the same letter are not significant at the 5 % HSD test .

The rapid increase in plant height at age 1-4 WAP due to the high response to absorb nutrients. This was confirmed also by the statement Aminudin and Chabib (2005) in Tripama, et al (2009) that the increase in plant height is at vegetative stage is the third and fourth weeks because the plants have a high response to absorb nutrients. While the first and second week of the plants are still experiencing adjustment due to transplanting from polybags. While in the fifth week of the plant goes into generative so vegetative growth began to decrease.

4.3. Stem Diameter

Results of analysis of variance showed that the spacing of and interaction between the two factors did not significantly affect the tomato plant stem diameter ages 2, 3, 4, 5 and 6 WAP. Growth is a process of cell

division (increase in number) and cell enlargement (increase in size). A number of other instructions related to the growth and development of plants are plant height, volume, leaf area, the addition of fresh weight and dry weight of plants (Gardner, et al., 1991).

4.4 . Fruit Diameter

Results of analysis of variance showed that the weed extract significantly affect the diameter of fruits per plant . While the plant spacing very significant effect to the diameter of fruit per plant . The interaction between these two factors do not affect the diameter of fruit per plant . The average diameter of fruits per plant due to the influence of plant spacing and weed extract listed in Table 4.4 below .

Table 4.4 . Average fruit diameter (mm) per plant is due Dose Effect of Plant Spacing and Weed Extract .

Extracts weeds dose	Plant spacing		
	J1 (50 x 50 cm)	J2 (50 x 60 cm)	J3 (50 x 70 cm)
Without extract (G0)	50.15c	25.77a	50.5e
C.rotundus extract 40 g /liter (G1)	46.28cde	41.33ab	40.44a
C.rotundus extract 80 g /liter (G2)	46.83cde	45.39bcd	44.89abcd
A.conyzoides extract 40 g / liter (G3)	48.28de	45.39bcd	42.33abc
A.conyzoides extract 80 g / liter (G4)	46.11cde	42.61abc	42.56abc

Description : The figures followed by the same letter are not significant at the 5 % HSD test .

4.5 . Leaf Area

Results of analysis of variance showed a significant effect on the spacing of the plant leaf area WAP age 12 , while at the age of 4 and 8 WAP WAP no effect on the spacing of the increase in leaf area of plants . Weed extract significant effect on leaf area WAP whereas age 12 at the age of 4 and 8 WAP no influence of weed extract . While the interaction between the factors of plant spacing and weed extract had no effect on plant leaf area increase .

Table 4.5 . The average of Plant Leaves Area 12 WAP due Dose Effect of Plant Spacing and Weed Extract.

Extracts weeds dose	Plant spacing		
	J1 (50 x 50 cm)	J2 (50 x 60 cm)	J3 (50 x 70 cm)
Without extract (G0)	3920.64m	3151.00k	724.502a
C.rotundus extract 40 g /liter (G1)	2570.22h	3653.49l	2107.47e
C.rotundus extract 80 g /liter (G2)	2816.08j	2134.53f	1005.03c
A.conyzoides extract 40 g / liter (G3)	4062.20n	8376.40o	2657.2i
A.conyzoides extract 80 g / liter (G4)	1555.50d	2158.87g	811.44b

Description : The figures followed by the same letter are not significant at the 5 % HSD test .

Added leaf area plants growing at the age of 1 to 4 WAP followed by a generative growth phase until the age of 8 WAP is more influenced by the high ability of plants to absorb nutrients. While at 12 WAP nutrients there are more absorbed for fruit ripening so many leaves that began to decline and fall. It reinforced by Aminudin and Chabib (2005) in Tripama, et al (2009) that the increase in plant height was in the vegetative phase, namely the third and fourth weeks because the plants have a high response to absorb nutrients. While the first and second week of the plants are still experiencing adjustment due to transplanting from polybags. While in the fifth week plant goes into generative so vegetative growth began to decrease.

4.6. Number of Fruit per plants

Results of analysis of variance showed there was no interaction between treatment plant spacing and type of weed extracts against the amount of tomato fruit. The treatment of these two factors also had no effect on the average number of pieces of tomato plants.

Table 4.6 . Average Number of Fruits per Plant is due Dose Effect of Plant Spacing and Weed Extract .

Extracts weeds dose	Plant spacing		
	J1 (50 x 50 cm)	J2 (50 x 60 cm)	J3 (50 x 70 cm)
Without extract (G0)	12.40a	8.48a	7.20a
C.rotundus extract 40 g /liter (G1)	7.33a	5.53a	4.67a
C.rotundus extract 80 g /liter (G2)	8.13a	7.60a	4.40a
A.conyzoides extract 40 g / liter (G3)	11.00a	8.07a	8.80a
A.conyzoides extract 80 g / liter (G4)	8.53a	6.03a	7.00a

Description : The figures followed by the same letter are not significant at the 5 % HSD test .

4.7 . Fruit Weight per Plant

Results of analysis of variance showed that the extract weeds and plant spacing significantly affect fruit weight

per plant . While the interaction between the two factors do not affect the weight of fruit per plant .

Table 4.7 . Weight average Fruit (g) per Plant is due Dose Effect of Plant Spacing and Weed Extract .

Extracts weeds dose	Plant spacing		
	J1 (50 x 50 cm)	J2 (50 x 60 cm)	J3 (50 x 70 cm)
Without extract (G0)	158.1a	168.8ab	230.4abc
C.rotundus extract 40 g /liter (G1)	242.3abcd	257.1bcd	287.2cd
C.rotundus extract 80 g /liter (G2)	252.6bcd	273.9cd	375.9ef
A.conyzoides extract 40 g / liter (G3)	328.5def	302.7cde	398.1f
A.conyzoides extract 80 g / liter (G4)	212.00abc	189.00a	210abc

Description : The figures followed by the same letter are not significant at the 5 % HSD test .

Results of analysis of variance showed there was no interaction between plant spacing and type of weed extracts on tomato plant fruit weight . Treatment weed extract significant effect on fruit weight per plant parameters . Weed extracts could be expected to reduce the number and types of pests so that plants can grow well on getting better fruit weight .

4.8 . Dry Weights of Tomato Crop

Results of analysis of variance showed that the extract significantly affect weed dry weight of tomato crop stover . Meanwhile, plant spacing and spacing of the interaction between the two and weed extract had no effect on dry weight of tomato crop stover .

Table 4.8 . Dry Weight average stover Tomato (g) due Dose Effect of Plant Spacing and Weed Extract .

Extracts weeds dose	Plant spacing		
	J1 (50 x 50 cm)	J2 (50 x 60 cm)	J3 (50 x 70 cm)
Without extract (G0)	24.93f	21.32def	16.15abc
C.rotundus extract 40 g /liter (G1)	14.53ab	12.85a	16.28abcd
C.rotundus extract 80 g /liter (G2)	18:33 bcde	20.73cdef	17.13abcd
A.conyzoides extract 40 g / liter (G3)	22.33ef	21.12cdef	33.28g
A.conyzoides extract 80 g / liter (G4)	25.07f	24.56f	23.83f

Description : The figures followed by the same letter are not significant at the 5 % HSD test .

Weed extract effect on dry matter accumulation of tomato plants. The average dry weight of tomato plants in the third stover plant spacing was not significantly different for the three types of plant growth does not lead to competition with tomato plants. This is consistent with the statement of Dahrul (2011) that coriander, lemongrass and basil suitable grown in planting tomatoes because roots are not deep, moderate growth rate and tolerant of heat and cold weather. Lemongrass fibrous roots are also good for preventing erosion. Therefore, it is highly recommended cropping pattern to be applied on dry land with relatively low soil fertility.

4.9. Leaf area index

Results of analysis of variance showed that the spacing of significant effect on plant leaf area index age of 12 WAP, while at the age of 4 and 8 WAP no effect on the spacing of the plant leaf area index. Extracts weeds and interaction between the two factors do not significantly affect leaf area index age of 12 WAP. While the interaction between the factors of plant spacing and weed extract had no effect on plant leaf area index increase.

Table 4.9 . Average Leaf Area Index Plant 12 WAP due Dose Effect of Plant Spacing and Weed Extract .

Extracts weeds dose	Plant spacing		
	J1 (50 x 50 cm)	J2 (50 x 60 cm)	J3 (50 x 70 cm)
Without extract (G0)	1.57a	1.05a	0.19a
C.rotundus extract 40 g /liter (G1)	1.03a	1.21a	0.56a
C.rotundus extract 80 g /liter (G2)	1.13a	0.71a	0.27a
A.conyzoides extract 40 g / liter (G3)	1.63a	2.79a	0.71a
A.conyzoides extract 80 g / liter (G4)	0.62a	0.72a	0.22a

Description : The figures followed by the same letter are not significant at the 5 % HSD test .

Added broad leaf plants growing at the age of 1 to 4 WAP followed by a generative growth phase until the age of 8 WAP is more influenced by the high ability of plants to absorb nutrients. While at 12 WAP nutrients there are more absorbed for fruit ripening so many leaves that began to decline and fall.

4.10. Type and Number of Plant Pest Organisms

In general, the number of pests that are in the vicinity of planting can be said not much good in terms of the type and number of pests. Early planting almost no weeds growing around the plantation. Similarly, the type of pest that can interfere with the plant. Entering the second week of after planting, start mealybug attacks on the leaves of tomato plants. These pests then become greatly reduced in number, especially when you start spraying of

Ageratum conyzoides extract.

5. Conclusion

Based on the description of the results achieved in the first year of research we can conclude the following matters:

1. Spacing significant effect on the diameter of fruits per plant and plant height significantly at the age of 5 WAP, number of fruits per plant, fruit weight per plant, dry weight crop, leaf area 12 WAP, leaf area index 12 WAP and very significant effect on fruit diameter . Weed extracts affect the number of fruits per plant, fruit diameter per plant, fruit weight per plant, dry weight crop, leaf area 12 WAP and plant leaf area index 12 WAP.
2. The interaction between these two factors affect the life of the plant height 5 WAP.
3. Plant spacing J3 (50 x 70 cm) with weed extract dose 80 grams/liter (G2 and G4) is the best treatment that can improve the productivity of cultivated tomato plants intercropped with aromatic plants (coriander).

Further research is recommended to use other types of aromatic plants (lemongrass and basil) with respect to time of planting in the soil before planting tomatoes (or in conjunction with tomato plants). This happens because each type of aromatic plants have special requirement to germinate so if used in crop intercropping should pay attention to the timeliness of planting. Appropriate planting time will ensure good growth and the effect of aromatics in pest control can be run more leverage.

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Figure 1. Interplanting Tomato Plant and Coriander

Figure 2. Weed Extracting Process

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